The deadly effects of losing health insurance*

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Abstract

The number of undocumented migrants in developed countries has increased in recent years, which has generated discussions about the extent to which access to public programs should be restricted for this population. This is the first paper that estimates the effects of restricting access to one of these public programs, health care, on mortality rates of undocumented immigrants. We exploit the natural experiment that arises from a reform implemented in Spain in September 2012 that introduced this restriction. We show that, during the first three years of implementation, the restriction increased the monthly mortality rate of undocumented immigrants by 0.31 deaths per 100000 individuals (which corresponds to 82 additional deaths each year). We also document small changes in the composition of the treated population with 5% of middle educated individuals being substituted by lower educated ones. However, this selective migration can only account for 3.45% of our mortality effects. Our results show the large effects of health insurance coverage on the health status of vulnerable populations and have important policy implications for developed countries currently receiving sizeable migration flows.

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I. Introduction

Undocumented immigrant flows to developing countries have increased substantially in recent years[1]. In Europe data from Frontex (European agency for border control) shows that in 2015, the year in which the refugee crisis started, around 2 milion people crossed the EU borders irregularly. In the USA, this is an issue that has been important primarely since the 1990's and data from the PEW research centre estimates that in 2014 more than 11 milion undocumented immigrants were living in the USA, which represents 3.5% of the total population.

These increases in undocumented immigration have put the immigration debate at the forefront of the political discussions. In particular, one of the items being discussed is whether and to what extent undocumented immigrants should have access to public benefits and public programs (note that this is also being discussed in the academic literature; see for example the paper by Guerreiro et al. 2019 on the optimal immigration policy).

In this paper we focus on one of these public programs, health care, and provide the first evidence of the impacts of restricting access to the public health care system for undocumented migrants on the mortality rates of this population. In order to do that, we exploit a reform that introduced these restrictions in Spain in 2012. Using population level data from mortality registers and a differences-in-differences strategy, our results show that restricting access to the public health system for the undocumented population lead to high increases in their mortality rates, by 0.31 deaths per 100000 individuals, which corresponds to an effect of about 82 additional deaths each year. At the same time, this restriction could also affect the decision of undocumented migrants of staying in the country. We rule out this possibility as we don't find significant decreases in the affected population after the reform. Nonetheless, using data from the Spanish Labour Force survey, we document changes in the composition of the undocumented population in Spain as the proportion with low levels of education increases after the reform. Thus, middle educated individuals leave the country and these are substituted by lower educated individuals. As health and mortality rates are linked to education, we provide a back of the envelope calculation to show that changes in education levels can only explain a small part, 3.45%, of the mortality effects that we find. We also show that the effects of the restriction are higher for amenable mortality, defined as deaths from causes that should not occur in the presence of timely and effective interventions. Furthermore, the event study model points towards the effects of the reform increasing over time, as should be

[1] In the literature, undocumented immigrants are also referred to as unauthorized immigrants, irregular immigrants or illegal immigrants and we use them as synonims in this paper.

expected for an outcome such as mortality.

We believe the paper makes, at least, two important contributions. First, as far as we are aware of, this is the first paper that looks at potential consequences of health care access for the undocumented population. This is an important contribution in terms of policy implications given the current increase in undocumented immigrant flows to developed countries mentioned above. There is, however, an extensive literature evaluating the effects of health insurance coverage on health for several sub-groups of the native population (infants, pregnant women, the elderly, or the poor; see Levy and Meltzer 2008, Dave et al. 2019, Courtemanche et al. 2017 and Sommers et al. 2017 (among others) for reviews and discussions of the literature; Finkelstein 2007 and Finkelstein et al. 2007 focus on the introduction of Medicare). Yet, none of these papers focus on the undocumented population. Our paper is also related to the literature studying the effects of the 2012 Deferred Action for Childhood Arrivals (DACA) initiative which granted work permits and freedom from deportation for a large number of undocumented immigrants in the US. Several papers document that the DACA initiative resulted in higher employment and income for the targeted population (Pope 2016), and better mental health outcomes (Giuntella et al. 2020 and Venkataramani et al. 2017).

A second contribution is that this is the first paper that looks at the impacts of restricting access to the public health care system on mortality. A big part of the literature has focused on expansions in coverage of the main health insurance programs in the US (Medicaid and Medicare) with most of these studies showing positive health effects[2]. However, the literature on health care restrictions is almost inexistent. There is one recent working paper by Tello-Trillo (2018) focusing on a 2005 disenrollment reform from the Medicaid program in Tennessee which looks at medical utilization and self-assessed health, but not at mortality. Therefore, although looking at a different group of the population, our results may be informative for current discussions on dismantelling some of the health care expansions in the USA for disadvantage groups of the native population or for some of the debates around Brexit in the UK.

The rest of the paper is organized as follows. Section II outlines the characteristics of the reform that restricted access to health care for undocumented immigrants. Section III describes the data and the identification strategy while Section IV presents the results of the models. In Section V we estimate the effect of the reform using alternative specifications and Section VI concludes.

[2]However, not all health care interventions necessarily lead to health improvements (Fisher 2003), and health insurance can induce risky health behaviors (Dave and Kaestner 2009; Dave et al. 2015).

II. The 2012 Spanish Health Reform

The Spanish National Health System offers free access to a comprehensive package of services and benefits covering primary care, specialized care and emergency care. It is funded almost entirely with taxes. Since 2002, the system is highly decentralized to the 17 Spanish regions (Autonomous Communities[3]), which are in charge of the management and provision of health care in their territories, and in designing and implementing legislation binding in the respective regions. Among other functions, the national government is in charge of designing and implementing national legislation applying to all regions and of undertaking the general coordination of the system. Until 2012, the coverage of the system was universal. All individuals living in Spain were entitled by law to receiving free access to the system irrespective of personal wealth, labor status or administrative situation in the country. In particular, undocumented immigrants were entitled to the same bundle of services as Spanish natives with the only requirement of being registered as residents in a municipality. This administrative procedure is relatively simple and it only requires the individual to document his/her place of residence in the municipal register. Examples of valid documents of residence are a letter from the landlord of the rented appartment or a bill from a service company (gas, electricity, etc.) with the name of the person and the address of the appartment. Once registered in the municipality, the individual can apply for a health care card that would be sent to his/her home and would entitle him/her direct access to the public health system[4].

In 2012, with the official aim of saving resources and dissuading "health tourism", the Spanish government implemented a reform of the health system with the approval of Royal Decree 16/2012. The new law, which came into effect in September 1 2012, restricted free access to the health care services for the population of undocumented immigrants, changing the universal nature of the system. In particular, the reform established that, from that point onwards, immigrants needed an official residence permit in Spain in order to be granted access to the system. The process to obtain a residence permit is long and many times unsuccesful; the immigrant has to be claimed by an employer for work purposes, or otherwise he has to demonstrate that he has sufficient resources to cover the living expenses during his stay in the country. Undocumented immigrants were restricted access to all the services offered by the National Health System, with three exceptions:

[3] Autonomous Communities are the 17 administrative units corresponding to the first level of regional decentralization in Spain. There are also two Autonomous Cities, Ceuta and Melilla, that are not included in our analysis

[4] Apart from guaranteeing access to health care, the registration also entitles undocumented immigrants to public education and other public services.

(1) Emergency care in the case of serious illness or accident, whichever the cause, until discharge; (2) Health care during pregnancy, birth and postpartum; and (3) Health care for individuals under 18 years old.

A precise figure of the number of individuals that have been restricted access to the health system as a result of the reform is difficult to obtain. Although the Spanish government has been reticent in providing this type of information, in a parliamentary response issued on November 15th 2013 (one year and a month and a half after the implementation of the reform) it stated that 748835 health cards had been withdrawn because the person was not residing legally in Spain when it was verified. In the "Spanish Program of National Reforms 2013", a document that the Spanish government sends every year to the Council of the European Union and to the European Commission explaining the reforms implemented by the government, it is explicitly stated that with the implementation of the Royal Decree 16/2012 and with the intention of "avoiding fraud regarding the obtainance of the Spanish health card", 873000 health cards of foreigners not legally residing in Spain had been withdrawn. This last number represents 13.87% of the immigrant population in Spain in 2012 and 1.86% of the total population. Some regional authorities tried to introduce a counter-balancing regional law granting access to the health care system for undocumented immigrants. However, as we are interested in the effects of the restriction on a strong health outcome such as mortality, and as individuals can move throughout the Spanish territory, we focus on the impact of the reform on the entire territory.

It is important to note that NGO's working in Spain had been doing mainly an information task and were lacking the capacity to implement an alternative service to provide health care for undocumented immigrants (mostly because they did not have the necesary infrastructure in place before the reform). Some of the NGO's, however, did a very intense job in collecting information on individual cases in which access to the health care system had been denied. In the appendix section we provide some of this individual cases which make it clear that the reform was implemented in a pretty strict way and, in some cases, even individuals that were legally entitled to public health care services were denied access. There is evidence, for example, of children being denied access to the system even if they were one of the three exceptions of the reform or of individuals with an officially regular situation in the country also being denied a health care card.

III. Data and Identification Strategy

A. Data

We use the *Death Registers by Cause of Death*, a dataset provided by the Spanish National Institute of Statistics, which registers all deaths occurred in Spain. We use data from the years 2009-2015 (2,766,658 deaths recorded in Spain), a period spanning several

years before and after the reform, implemented in September 2012. For each individual death, the dataset contains information on the date of death, the cause of death, the nationality and country of birth of the individual, his/her gender, age and date of birth, and the Spanish region where the death occurred.

As is the case with most official datasets, the mortality registers (and the population statistics) do not provide information on the immigrant administrative status. Therefore, we calculate a proxy of each individual's undocumented status using data from the 2011 Census (which refers to the situation on the 1st January 2011) and data from the Ministry of Employment and Social Security on the number of residence permits in 2011 by nationality (other papers in the USA also use proxies for undocumented immigrants; for example Amuedo-Dorantes and Lopez 2015). For each nationality, we calculate the percentage of individuals living in Spain in 2011 in an irregular situation in the following manner; from the 2011 Census we take the number of individuals from a given nationality living in Spain and we substract the number of individuals from that same nationality that have a residence permit in Spain in 2011. Thus, we get the number of individuals without a residence permit in 2011 for a given nationality. Then we divide it by the total number of individuals from that nationality (again from the 2011 Census) in order to get a percentage of undocumented individuals by nationality. This procedure gives us a snapshot picture of the percentage of undocumented individuals in Spain for each nationality one year before the introduction of the reform. It is important to note that we do not include as undocumented immigrants individuals with a tourist visa or those with a student visa. We use only those nationalities for which there is at least one death in our sample period. The map in Figure A1 (see Appendix) summarizes this information with lighter coloured countries featuring lower percentages of undocumented population living in Spain in 2011 and darker countries showing higher percentages of undocumented population. For countries in grey color we do not have any observation in the death registers in our sample period and, therefore, are not included in our analysis. Table A1 in the Appendix reports the calculated percentage for each country (these numbers are very similar than the ones calculated by Gonzàlez-Enríquez in 2009). Because the undocumented immigrant population is younger than the native population (with a very low proportion of elderly individuals), we restrict both groups to individuals under 65 years old to make the mortality patterns of both groups more comparable[5]. We also restrict the main analysis to individuals over 18 years old, as the reform did not affect under-age individuals. In any case, we provide evidence that there is not effect for individuals in this younger age

[5]Also, in 2012 copayments for some drugs were introduced for retired individuals (65+ years old) so the exclusion of this group is crucial to isolate the impacts of the health care access restrictions

group. Therefore, the final number of deaths between 2009 and 2015 is 406,579.

B. Identification Strategy

We collapse the individual level data by country of nationality and year and month to compute the mortality rate for each country of nationality and time period (at the year-month level). The corresponding population numbers to be used in the denominator for the mortality rates are extracted from official population statistics provided by the Spanish National Institute of Statistics. We first use as treatment variable the percentage of undocumented population for each nationality that we have calculated (shown in Figure A1 and Table A1 in the Appendix) in order to identify the effect of the restriction in access to public health care on the mortality rate of undocumented migrants. Therefore, those nationalities with a higher proportion of undocumented migrants in 2011 will be "more treated" than those nationalities with lower percentages of undocumented migrants in Spain. In this specification, those with a zero percentage of undocumented serve as the control group. It is important to note that this control group includes several countries of nationality with no undocumented population in Spain (not only Spanish nationals) as also shown in Table A1 in the Appendix. Thus, we estimate a differences-in-differences model in which we compare the evolution of the mortality rates between the control and treatment groups before and after the reform:

$$Y_{ymc} = \beta_0 + \beta_1 PercU_c + \beta_2 After_{ym} + \beta_3 PercU_c * After_{ym} + \delta_y + \alpha_m + \lambda_c + \upsilon_{ymc} \quad (1)$$

Where subscript y refers to a specific year, m to a specific month of the year and subscript c refers to a specific country of nationality. Y_{ymc} is the mortality rate for each time period (year and month) and country of nationality. $PercU_c$ is our continuous treatment variable which reports the percentage of undocumented individuals for each nationality c. $After_{ym}$ is a dummy variable equal to 1 for observations after the implementation of the reform in September 2012 and equal to 0 for observations before the reform. We include fixed effects of year (δ_y), month of the year (α_m) and country of nationality (λ_c). Thus, we are controlling for any differences in mortality rates due to seasonality (with the month fixed effects) or yearly events and we also account for differences in mortality rates across countries of nationality. υ_{ymc} is the error term. Standard errors are clustered at the country of nationality level (shown in parentheses) and population weights are used in the estimation.

Our coefficient of interest is β_3, which measures the differential effect in the mortality rate between the treated and control group that results from the implementation of the

reform. Under the assumption of parallel trends in the mortality rates of the two groups in the absence of the reform, and under the assumption that there are no other changes differentially affecting the two groups at the same time as the reform, β_3 measures the causal effect of the restriction in health care access on the mortality rate of the undocumented immigrant population.

Although we provide evidence of the existence of parallel trends for the model specified above, there could still be some concerns with the fact that the treatment and control group might potentially be different. Therefore, we run an alternative specification using the same model than in equation 1 but restricting the sample to include only those nationalities with a positive share of undocumented immigrants. In this case, we do not have a control group and we only use the variation from the countries with a positive share of undocumented migrants to identify the effects of the reform on mortality. As we have a lower number of countries (24 countries), in this case standard errors are calculated using the Wild Bootstrapping method proposed in Cameron et al. 2008 and p-values are reported in brackets.

IV. Results

A. Base Results

To provide preliminary descriptive evidence on the effects of the reform, Figure 1 shows the evolution of the mortality rates for the treated and control group during the analysis period 2009-2015, spanning several years before and several years after the implementation of the reform in September 2012 (indicated with a vertical line). The figure shows monthly mortality rates expressed as deaths per 100000 individuals (in dots) and a linear fit model.

Figure 1.A shows the mortality patterns for the treated group (nationalities with a positive percentage of undocumented immigrants) while Figure 1.B shows the same thing for the control group (nationalities with a zero percentage of undocumented immigrants). The Figure provides preliminary evidence that the reform has fostered an increase in the mortality rate of undocumented immigrants. Before the implementation of the reform, the mortality of the treated and control group followed a parallel mild decreasing trend. As this is a period of an ongoing economic crisis (that began in 2008), this result is consistent with several papers in the literature reporting reductions in mortality during economic recessions. Furthermore, the implementation of the reform has no effect on the mortality trend of the control group, which keeps decreasing at a similar pace than before the reform. On the contrary, the mortality of undocumented immigrants reverses the downward trend and starts increasing after the implementation of the reform. The increase is quite substantial. Furthermore, the timing of the increase is consistent with

what we would expect, with the effects on mortality resulting from treatment interruptions and lack of diagnoses (because of no regular screening) increasing over time.

Table 1 Columns 1 and 3 provide the results of the estimation of the differences-in-differences models (equation 1) for the two samples (with and without the control group). The dependent variable is the monthly mortality rate per 100000 individuals.

In the two specifications the results indicate a strong and significant positive effect of the introduction of the restriction on the mortality rate of undocumented immigrants. For the regression with the control group (column 1), the differences in differences coefficient indicates that, in the four years from its implementation in September 2012, the reform has increased the monthly mortality rate of undocumented immigrants by 0.018 deaths per 100000 persons per each unit increase in the percentage of undocumented. Basically, when we move from a situation of a zero probability of being undocumented (percentage equals zero) to the situation of a 100% probability of being undocumented, the monthly mortality rate increases by 1.8 deaths per 100000 persons. A similar impact is found from the regression without the control group (column 3), an increase by 0.0176 deaths per 100000 persons per each unit increase in the percentage of undocumented.

A simple back of the envelope calculation will facilitate the interpretation of the magnitude of the effect. The average estimated percentage of undocumented individuals in 2011 for the countries that we analyse is around 17.6% (once we adjust by the relative immigrant population and the relative percentage of undocumented individuals of each country of nationality with a positive percentage of undocumented immigrants). Thus, the policy effect estimated in column 3 (0.0176 deaths per 100000 individuals per each unit increase in the percentage of undocumented) translates into an impact of 0.31 deaths per 100000 individuals each month (0.0176*17.6). Furthermore, as seen in Figure A2 (see Apppendix), there are around 2.2 million individuals from countries with a positive percentage of undocumented immigrants living in Spain in 2011. Therefore, the estimated effect of 0.31 deaths per 100000 individuals each month corresponds to an absolute number of about 82 deaths each year[6]. That is, the estimates suggest that, since its implementation in September 2012, the reform has resulted in about 82 additional deaths per year. However this number should be interpreted as a lower bound estimate because our calculations on the number of undocumented individuals is, most likely, biased downward due the reporting and identification problems of this group of undocumented migrants and the corresponding lack (and poor quality) of the data available.

[6]The calculation corresponds to 0.0176 deaths per 100000 persons per each unit increase in the percentage of undocumented x 17.6 average percentage of undocumented over total immigrants x 2.200.000 immigrants x 12 months / 100.000 persons = 82 deaths per year

Moreover, Columns 2 and 4 of Table 1 reports the results separately for each post-reform year in order to understand the dynamic effects of the policy. We can see that the effects increase substantially over time in column 2 while the trend is not so clear in the fourth specification.

Finally, it can be stated that the specification without the control group (as well as the country fixed effects) already address some of the possible age differences between countries as the immigrant population have similar age profiles. However, we also include a specification with the logarithm age-adjusted mortality rate as the dependent variable in table A2 (see Appendix). We can see that the coefficient capturing the effects of the reform (column 1) is positive and sizeable but marginally not significant at conventional significance levels. However, once we focus on the amenable mortality (which includes the types of deaths are can be prevented with timely access to the health care system, column 3), it has a stronger and significant impact which clearly increases over time (column 4).

In order to explore the heterogeneity of the effect, we present the results differentiated by gender and age groups. In Table 2 we can see that in Columns 1 and 2 (specification with the control group), most of the effects are sizeable and significant for the sub-group of men and the coefficient for women is closer to zero and not significant. However, in Columns 3 and 4, when we restrict the sample to include only the treated group of undocumented migrants, we can see that the effects are sizeable for both men and women. If we develop a more detailed analysis and focus on the impact on amenable mortality (deaths that could be averted by timely access to the health care system) in columns 5 and 6, the effect for men is a bit larger than the effect for women and both coefficients are significant (the effect for men is around 130% compared to the effect for women). Overall, we believe that these results point towards the effects of the reform not being much different between the two genders. It is important to keep in mind that, traditionally, men have been shown to have a stronger incidence of diseases as well as worst health behaviours. This is also the case in Spain and for the immigrant population in particular (see, for example, Henares-Montiel et al. 2018). This evidence could partly explain why the restriction in health care access had a somewhat larger increase in the men's mortality rate.

Table 3 reports the results for three different age groups (ages 2-17, ages 18-39 and ages 40-64)[7]. As before, the first three columns report the results using both the treatment and the control groups while columns 4 to 6 use only the treatment group to estimate the

[7]The younger age group does not include babies aged 0 and 1 as they could be affected by mother's health care access as well as her behaviours during the pregnancy period.

effects of the policy. We can see that the reform significantly increases mortality rates in the three age groups. It is important to note that, looking at Columns 2 and 3, we observe that the impact is somewhat weaker for the older group of individuals. The effect on mortality for the 18-39 group is 1.5 as large as for the 40-64 age group. In Columns 4 to 6 we can see that the difference in the effect between the two groups is larger, as the effect on mortality for the 18-39 group is 2.3 as large as for the 40-64 age group. Moreover, column 6 show the expected positive sign but it is not statistically significant. The difference between the two age groups affected by the reform is consistent with a treatment success narrative. If we look at the estimates, the older group show larger estimates in absolute terms as treatment interruptions and lower screening levels are expected to have a higher impact on the health of the 40-64 age group (for example, some regular screening tests are only applied after a certain age threshold). However, once we consider the pre-reform mortality rates of the two age groups, the younger group shows a larger impact of the reform as mortality rates are lower and treatments are more efficient at this younger ages.

It is important to note that we also observe increases in mortality for the younger group of undocumented immigrants in column 1, although the coefficient is no longer significant when we estimate the model without the control group (column 4). This is important because, as explained above, those aged between 2 and 17 were, in principle, one of the exceptions of the reform. These results could be driven by either an increased fear of parents being reported to the immigration authorities and/or mistakes in the administrative processes of the reform that would impede the fulfilment of the exceptions included in the law. There is evidence of similar effects in other countries: for example in the USA, Watson (2014) finds strong evidence that federal immigration enforcement policies reduce Medicaid participation for children of non-citizens even when children are entitled to Medicaid because they are USA citizens. Apart from that, there is also evidence that in Spain the exceptions to the health care access reform were not respected in some cases. In the appendix section we present anecdotal evidence collected by NGO's of individual cases of children that were denied access to the health care system as well as children that were denied the health care card even if they had a regular situation in Spain. Therefore, given the existence of these pitfalls in the implementation of the exceptions and the evidence of similar effects in other countries, it seems that it would be plausible to observe an increase in mortality for the younger age group.

However, we further explore this issue in Table 4 where we report the two specifications for amenable and non-amenable mortality. If we focus on amenable mortality (columns 1 and 2), the estimate is still positive but not significant.

B. Cause of Death: Amenable Mortality

Amenable mortality[8] is generally defined as "deaths from causes that should not occur in the presence of timely and effective interventions" (Holland et al. 2009). It has been used in previous studies mainly as a measure of the performance of the health system (see, for example, Nolte and McKee 2008, 2011). In those studies, which compare amenable mortality over time or between countries, the idea is that the performance or quality of a health care system can be measured by the amount of deaths that can be avoided if timely and effective medical care is available.

In our study, if the effects that we find are indeed attributable to a lack of health care access, we should find that the effects are stronger for conditions in which timely and effective medical care has a larger impact on mortality, that is, we should find that the effects are stronger for amenable mortality. This is precisely what we study in this section[9]. Using the International Classification of Diseases (ICD), we use the classification of diseases elaborated in Sommers et al. (2014) to identify causes of death amenable to health care. It is important to note that the classification of the causes of death between amenable and non-amenable mortality in Sommers et al. (2014) is not exact and should be interpreted with care; it does not imply that the non-amenable causes of death cannot be treated by the health care system but rather that they are less responsive to having access to the health care system. Therefore, we further restrict the conditions on our non-amenable mortality specification and use the classification in OECD (2019) for causes of death non-amenable to health care. We estimate the differences-in-differences models separately for these two types of causes of death[10]. In each case, mortality rates are computed as the number of deaths due to the specific conditions (amenable or non-amenable conditions) divided by the total population for each nationality and year-month, as before. Figure 2 shows the descriptive graphs of the mortality patterns for the treated and the control group for amenable mortality. In panels A, B and C we show the graphs for each tercile of undocumented migrants as defined by the percentage of undocumented that we use as treatment variable. Panel D plots the data for the control group. As it can be seen in panel A the death rate for amenable mortality for individuals in the upper tercile

[8] Also termed avoidable mortality, treatable mortality or preventable mortality in the literature.

[9] Sommers (2017) finds that the reduction of mortality that resulted from Medicaid expansions in the 2000s was indeed larger for amenable causes.

[10] The detailed list of conditions classified as amenable to health care can be found in Table 1 of the Supplement of Sommers et al. (2014). Instead of using the conditions not appearing in this list and classifying them as non-amenable, we use the conditions classified by the OECD as non-treatable and non-preventable as this additional restriction identifies more precisely those conditions that are non-amenable to the health care sector.

of the proportion of undocumented migrants was slightly decreasing before the reform and, once the reform is introduced, we observe a jump in mortality rates followed by an increasing trend in the years after the implementation of the reform. In panel B, for the middle tercile, we also observe a similar reversal of the preceding pre-reform term which turns positive and increases smoothly once the reform is implemented. On the contrary, for the lower tercile (panel C) there is no observable impact of the reform. If we focus on the figure for the control group, shown in panel D, we can see that the mortality rate due to amenable mortality was also slightly decreasing before the policy and it continues in the same trend after the reform, so no impact is observed. Table 5 Columns 1 and 5 show the results of the estimation using both the treatment and the control group (similar to the model shown in Figure 2) for amenable (column 1) and non-amenable (column 5) mortality and we can see that the coefficients capturing the effect of the policy is much larger and only significant for amenable mortality. In fact, in columns 5 and 7 we can see that, for the model with and without the control group, the effect of the reform is very small and non significant for non-amenable mortality. Furthermore, in Column 3 the impact for amenable mortality for the group restricted to only countries with a positive proportion of undocumented is also positive and highly significant. In Columns 2 and 4 we estimate the same model but interact the treatment variable with each of the four post-reform years. We can see that the effect for amenable mortality is strong and significant in the following years after the implementation of the reform, increasing its magnitude and significance over time. On the contrary, for non-amenable mortality we can see in Columns 6 and 8 that the effect is very close to zero and non-significant for the all the post-reform years reported.

Overall, the results show that the reform has a much higher impact (and only significant) for those types of deaths that are amenable to the health care system. The results, therefore, provide clear evidence that the reform has only resulted in increased mortality from those causes of death more amenable to health care, as we would expect.

We go one step further and in Table 6 we show the results for specific groups of causes of death following the International Classification of Diseases (ICD 10).[11] We can see that the strong and significant increases in mortality are due to infectious diseases, tumors, endocrine, circulatory, respiratory and digestive diseases. In fact, the single biggest increase in the number of deaths as a result of the reform comes from tumors. Cancers in Spain are treated in a few public hospitals which have a specialized oncology department with the latest innovations in treatments and technology. Before the reform, both undocumented immigrants and the rest of the population in Spain were receiving the same treatment for

[11] Results of diseases for which there are less than 2% of deaths in our sample are not shown.

cancer in those specialized public hospitals while, after the reform, undocumented migrants were no longer able to access the public health care system. Furthermore, cancer drugs are also only available at no cost in public hospitals. Thus, part of the increase in mortality from cancer could also be attributable to treatment interruptions. We believe that these results provide additional evidence of the importance of getting access to the health care system and the potential negative consequences of restricting this access for a vulnerable subgroup of the population.

In Column 14 of Table 6 we can see the results for mortality due to external causes, which include all types of accidents. As explained above, emergency care in case of accidents constitutes one of the exceptions of the health care reform and can, therefore, be used as a placebo test. We can see that the size of the coefficient for external causes of death is small, negative and non-significant so that the reform did not affect the probability of dying when suffering from an accident, as this type of events were excluded from the health care access ban.

C. Parallel Trend Assumption and Timing of Effects

Although both our treatment and control groups are not restricted to individuals from one nationality (but they include individuals from several different nationalities), it could still be possible that some other factor could be affecting the mortality rates of either the treated or the control group before the reform. If this is the case, then the parallel trend assumption would not be fulfilled. To alleviate this concern, we also present the results using an alternative sample that includes only undocumented migrants and exploits the heterogeneous probability of being undocumented for individuals of different nationalities.

However, we also provide a more formal test of the existence of parallel trends in the mortality rate of our treated and control group before the reform by augmenting the differences-in-differences regression with leads and lags before and after the introduction of the policy. At the same time, this model will allow us to investigate the time pattern of the policy effects. In particular, we estimate event study models of the form:

$$Y_{ymc} = \beta_0 + \beta_1 PercU_c + \sum_{i=-4}^{3} \alpha_i Year(i) + \sum_{i=-4}^{3} \theta_i PercU_c * Year(i) + \delta_y + \alpha_m + \lambda_c + \upsilon_{ymc} \quad (2)$$

Where $Year(i)$ is the ith year before/after the implementation of the reform. We include the same fixed effects than in equation 1. Leads and lags are specified in years to get a more visible idea of the existence of parallel trends in the outcome variable. However,

these are not calendar years but each lead/lag represents exactly 12 months before/after the reform (the year in which the reform is introduced goes from September 2012 to August 2013, the first year after is from September 2013 to August 2014, and so on). That is the reason why we can also include month and calendar year fixed effects. We have set the base year (omitted in the regression) as the year before the implementation of the reform. The coefficients on the interaction terms between $PercU$ (which is the percentage of undocumented for those nationalities with a positive percentage of undocumented in 2011) and each of the years (the θ_i), therefore, measure that year's increase in the difference in mortality rates between undocumented immigrants and the control group with respect to 1 year before the implementation of the reform. The years go from 4 years before implementation to 3 years after. To facilitate visualization, Figures 3 and 4 show plots of the interaction coefficients with 95% confidence intervals. The figures also report, for each year, the percentage change in the mortality rate with respect to the base year (1 year before the implementation of the reform) of a one percentage point increase of the undocumented proportion.

We can see in Figure 3 that the pattern of the coefficients provides clear evidence of the existence of parallel trends before the reform in the mortality rates of the treated and control groups. The coefficients for the four years before the implementation of the reform are not statistically different from 0, which indicates that the mortality of both groups follows a parallel trend before the reform. The coefficient increases in the year after the reform is introduced. At the same time, the magnitude of the coefficient increases substantially in the following year after the introduction of the reform. Overall, the results of this event study model suggest that there are no other unobserved factors differentially affecting the mortality of the treatment and the control group before the reform. The timing and the magnitude of the coefficients are also consistent; arguably, one expects that both treatment interruptions and lower diagnoses rates would take some time to be translated into deaths for the majority of diseases.

Figure 4 shows the event study results for both amenable and non-amenable mortality. We can see both the existence of parallel trends before the implementation of the policy as well as the strong increase in mortality after the policy which occurs only for amenable mortality. We can appreciate the strong impact of the reform in amenable mortality compared to all mortality shown in figure 3. For instance, if we consider the population-adjusted average proportion of undocumented immigrants from the countries analysed (around 17.6%), we estimate an average increase of 16.7% on immigrant mortality three years after the reform. However, if we focus only on amenable diseases, this number goes up to 34.3%.

D. Selective Migration

Although the results presented above show the robustness of our identification strategy, there is one factor that could be biasing our results. It could be the case that the restriction in access to health care may induce some undocumented immigrants to migrate to neighbouring countries or to their countries of origin in the lookout for better access to health care. If this is the case, and this migration is related to their health condition, this phenomena could be biasing our estimates. In this section we perform several robustness checks to study this possibility. First, Figure A2 in the Appendix shows the evolution of the population of our treated group and, although there is a decreasing trend since 2009 because of the ongoing economic crisis in Spain, this reduction in the treated population does not seem to accelerate after the reform. To provide a formal proof for the lack of a migratory response, we estimate the same type of differences-in-differences models outlined in equation 1 above but using the log of population and the population in numbers as the dependent variables. That is, we formally test whether the reform induced a differential change in the population of undocumented immigrants with respect to the population in the control group. Table 7 shows the results of this estimation for both genders (columns 1 and 4) as well as for men (columns 2 and 5) and women (columns 3 and 6) separately. The first three columns present the results for the dependent variable being the log of population while the last three columns show the results for population in numbers.

We can see that none of the interaction terms capturing the impact of the reform is significant, pointing towards the lack of a migration response from undocumented migrants, as was already suggested by Figure A2. Most undocumented migrants come from Africa, Latin-America or Asian countries and, although access to health care may be an important element in the decision to migrate, our results show that restricting access to the health care system does not provide incentives for undocumented migrants to leave the country. Furthermore it is important to note that, even if none of the population results are significant, the coefficients for men (columns 2 and 5) are non-consistent as the former is negative and the latter positive while, as showed above, a slightly larger part of the mortality effects are driven by men. This reinforces the idea that our mortality findings are not biased by changes in the population of undocumented migrants.

Finally, even if there are no significant reductions in the treated population as a result of the reform, individuals that leave and enter the country after the reform could be, to some extent, selected in health characteristics. In order to explore this possibility we use data from the second quarter interviews of the Spanish labour force survey from 2009 to 2015. We estimate the same model than in equation 1 but using as dependent variables different educational categories and age groups, which are features closely related to the

health status[12]. More precisely, we run regressions for the following binary dependent variables: the individual has primary education or less, he/she has secondary education, tertiary education, less than 10 years old or less than 50 years old[13]. We include fixed effects of region in Spain, region of nationality of the individual (we don't know the exact nationality but the region of nationality: see Table S1 for a list of regions and countries included) and year. Standard errors are clustered by region of nationality. We can see in Table 8 that undocumented immigrants after the reform are less likely to have secondary education and are more likely of having primary education or below. However, the change in educational achievement of undocumented migrants after the reform is quite small; there is a decrease by 4.85% in those undocumented migrants with secondary education and these are substituted by lower educated migrants (there is an increase by 4.48% of undocumented migrants with primary education or below).

As it is well known that lower educated individuals have higher mortality rates, in order to asses how much of our mortality effects can be explained by the differences in education of undocumented migrants after the reform, we perform a back of the envelope calculation in the following way: We calculate mortality rates by educational category for undocumented immigrants in 2012 using the 2011 Census and death registers by education level in 2012 (which is the first year in which death registers include information on educational achievement). Our estimates show that mortality rates of undocumented immigrants with primary education and below are 45.19 per 100000 individuals per year: mortality rates for those with secondary education are 28.08 per 100000 per year and mortality rates for those with tertiary education are 25.66 per 100000 per year. Thus, 17.11 more undocumented immigrants with primary education or less are dying (per 100000) every year with respect to those with secondary education. As the change in educational composition affected almost 5% of the undocumented population, and we already showed that the percentage of undocumented individuals is 17.6% in the countries included in our analysis, this means that after the reform there were 16557 more undocumented migrants with primary education or below. Therefore, the increase in the number of deaths due to the change in the educational composition of undocumented immigrants is only of 2.8 more deaths per year, which accounts for less than 3.45% of the mortality effects of the reform (an increase in mortality of 82 undocumented immigrants per year).

Overall the results in this section suggest that, although based on observable characteristics there is some evidence of selective migration among undocumented migrants

[12]Unfortunately, we do not have any dataset with information on health characteristics and country of nationality for the years 2009 to 2015.

[13]We have also run regressions with different age groups and the results are also not significant.

after the reform, this can only explain a very small part (3.45%) of our estimated mortality effects, providing further credit for the causal interpretation of the effects presented in the previous sections. Of course, we are only able to test selection based on observable characteristics that are related to health outcomes but we are unable to rule out selection based on unobservable characteristics.

V. Alternative Specifications

A. Double Nationality

The death register includes both the country of nationality as well as the country of birth. Thus, in this section we use this distinction in order to estimate regressions comparing individuals of the same country of birth but with different nationalities. Individuals from European Union countries were, in principle, still able to access the health care system in Spain after the reform; therefore, we select a sample of individuals born outside the EU. Then, we use the same differences-in-differences model than in equation 1 to compare differences in mortality rates after the reform for individuals with a EU nationality versus those without a EU nationality (third country nationals) from the same country of birth. Thus, individuals born in a EU country are not included in the sample. In the regression we include month, year and country of birth fixed effects and standard errors are clustered at the country of birth level. The treatment group will be those individuals born in a non-EU country and without EU nationality and the control group will be individuals born in the same non-EU country but with EU nationality. As in our baseline regressions, we only include individuals between 18 and 64 years old and we include population weights in the model.

Table 9 shows the results of this specification for the sample including all nationalities outside the EU (also those that have a 0 percentage of undocumented, which will be included in the control group) in Columns 1 and 2, as well as the sample that only includes those nationalities with a positive percentage of undocumented (Columns 3 and 4). We can see that the estimated effects of the health care access reform are positive and significant in the four specifications (controlling only for country of birth fixed effects in the first and third columns and additionally controlling for year and month fixed effects in the second and fourth columns).

When we compare only undocumented immigrants born in the same (non-EU) country, the estimated effects of losing health care insurance are quantitatively a bit smaller than in our baseline regressions. We believe that this is consistent with the fact that this is a selected group of countries in which some of its citizens have access to the EU nationality. Therefore, these represent higher income countries of origin. In fact, the process of gaining EU citizenship is a much easier process for individuals from Latin-American

countries than for individuals from African or Asian countries, for example. Thus, this can explain why the results of the reform on mortality are quantitatively a bit smaller for this selected sample.

In any case, with this alternative specification the results go in the same line than in our baseline model and reinforce the conclusion of important mortality effects of the health care reform.

B. Regional level estimates

In this section, we use an alternative specification to try to account for the fact that health care and immigration policies are, to a certain extent, run at the regional level in Spain (at the level of Autonomous Communities). Although the law was issued at the national level and affected the entire Spanish territory, there were some attempts by regional authorities to circumvent the prohibition. Of course, if you are very sick you would have incentives to move to another region looking for access to the health care system. Furthermore, as explained above, even in regions that tried to circumvent the national law, there is evidence from NGO's reports that the law was also applied in those regions. Nonetheless, in order to control for any remaining potential differences at the regional level, in this section we collapse the data at the regional level for each month, year and country of nationality. Again, we do that for two samples; the sample including all nationalities and the sample including only those nationalities with a positive percentage of undocumented. For these two samples, we now run the analysis at the regional level which allows us to include both regional fixed effects (to control for any fix differences in mortality rates at the regional level) as well as linear-specific regional trends (which will allow us to control for any smooth changes in regional policies affecting mortality rates).

Therefore, the model that we estimate is:

$$Y_{ymruc} = \beta_0 + \beta_1 PercU_c + \beta_2 After_{ym} + \beta_3 PercU_c * After_{ym} + \lambda_r * t + \delta_y + \alpha_m + \lambda_r + \upsilon_{ymruc} \quad (3)$$

Where Y_{ymru} is the mortality rate of undocumented immigrants or the control group, u, in year y, month m, region r, and country of nationality c, $PercU_c$ is the continuous treatment variable used in our baseline specifications which captures the percentage of undocumented for each nationality in 2011 in Spain. $After_{ym}$ is a dummy variable equal to 1 for observations after the reform, $\lambda_r * t$ is a linear specific regional trend for each of the 17 regions in Spain and δ_y, α_m and λ_r are year, month and region fixed effects. υ_{ymruc} is an error term. Standard errors are now clustered within regions and observations are population-weighted.

Results are presented in Table 10. Columns 1 and 3 show the results including region, year and month fixed effects while column 2 and 4 additionally include linear specific regional trends. The first two columns show the results for the sample including all nationalities while columns 3 and 4 refer to the results for the sample including only undocumented migrants. We can see in the four columns that we estimate a positive and significant increase in mortality rates after the reform for undocumented immigrants. Also, it is important to note that the inclusion of the region specific linear trends changes minimally the significance and magnitude of the coefficients of interest, reinforcing the lack of regional changes that can affect mortality rates and reinforcing our baseline results. In fact, the size and significance levels of the regional estimates shown in Table 10 are very similar to the size and significance levels obtained in our baseline regressions in the first two columns of Table 1.

Overall, the results in this section show that we also find significant mortality effects of the reform when we run alternative specifications and that both the significant levels as well as the magnitudes of the reform are remarkably similar across specifications, which gives further credit to the causal interpretation of our estimates.

VI. Conclusions

The unprecedented increase in international migration flows to developed countries over the last decades has placed immigration issues at the forefront of media coverage and political debates in destination countries. The recent refugee crisis in the EU or the steady increase in inflows of undocumented migrants in the USA, with recent estimates pointing towards more than 11 undocumented individuals living in the USA in 2014, are only two of many examples of these migratory pressures. The political debate has often been focused on the potential negative consequences of immigration for the labour market prospects of the native population or its negative effect on the public accounts. In this context, many governments in developed countries are implementing restrictions in access to public programs for undocumented immigrants, with little knowledge on the consequences that these type of restrictions can have both for the affected population as well as for the society as a whole. In this paper, we contribute to this discussion by focusing on one of these programs, public health care, and assessing the potential consequences of restricting access to the system for undocumented immigrants.

In order to do that, we focus on a reform that was passed in Spain in 2012 that introduced this restriction and we study the impact on mortality rates of undocumented immigrants. We use population level data from mortality registers and a novel method to calculate a proxy for undocumented status to run differences-in-differences models. Our results show that the restriction resulted in large and significant increases in mortality rates of the affected population. In particular, we estimate that the reform increased the

monthly mortality rate of undocumented immigrants by 0.31 deaths per 100000 persons during its first four years of implementation, an effect that corresponds to 82 additional deaths per year as a result of the reform. We also show that the effects of the restriction in access to health care are much higher for deaths considered amenable to health care, that is, deaths that would not occur in the presence of timely and effective medical care.

Reasonably, our analysis shows that the effects of the reform on mortality increase with respect to time after implementation. Thus, there are reasons to believe that the long term effects of the reform are going to be even stronger. Although we do report some selective migration of undocumented migrants with respect to education, we provide evidence that these movements can only explain 3.45% of our mortality effects.

Overall, these results suggest that health insurance coverage can have large impacts on the health status of vulnerable populations with few alternatives to access health care, and provide evidence that restrictions in public health insurance coverage specifically targeted to the immigrant population have strong negative consequences for their health. Finally, it is possible that these negative effects can produce spillover effects to the native population as one of the increases in the mortality rate that we document comes from infectious diseases. Of course, as health is related to other outcomes such as labour market prospects, infant health or adult disability ignoring our results might result in higher social insurance costs in the future in terms of increases in disability benefits, reduced employment probabilities or worse health outcomes at birth for undocumented migrants' children.

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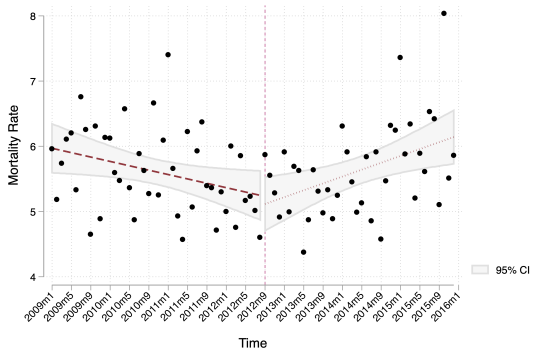
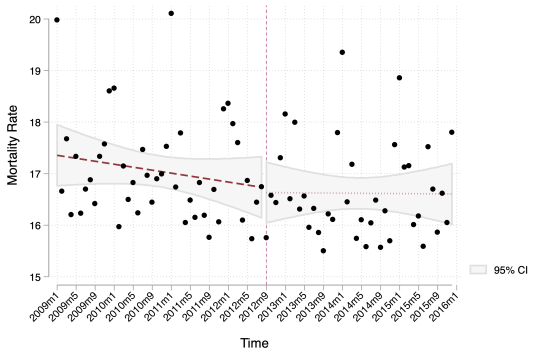
Figures and Tables

FIGURE 1—EVOLUTION OF MORTALITY RATES FOR TREATED AND CONTROL GROUPS DURING ANALYSIS PERIOD 2009-2015

(A) NATIONALITIES WITH % OF UNDOCUMENTED > 0



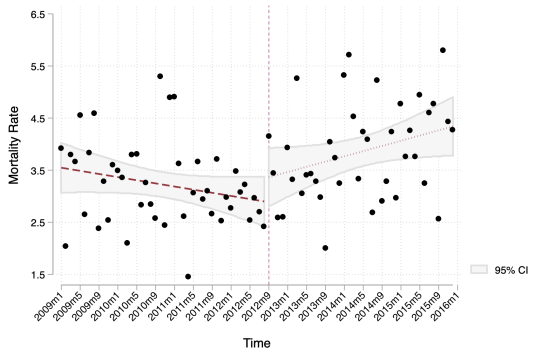
(B) NATIONALITIES WITH % OF UNDOCUMENTED = 0



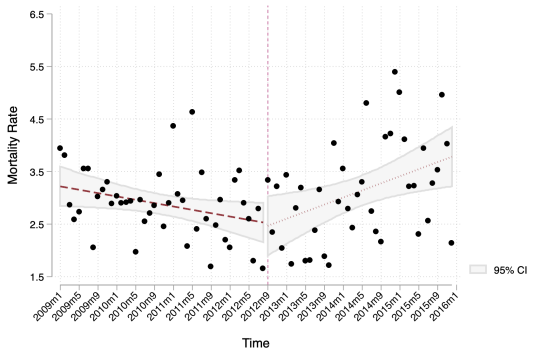
Notes: The figures show scatterplots of the monthly mortality rates expressed as deaths per 100000 individuals. They include linear fits with 95% confidence intervals. The vertical line indicates the implementation of the restriction in access the healthcare.
Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

FIGURE 2—EVOLUTION OF MORTALITY RATES FOR TREATED AND CONTROL GROUPS DURING ANALYSIS PERIOD 2009-2015 FOR AMENABLE MORTALITY

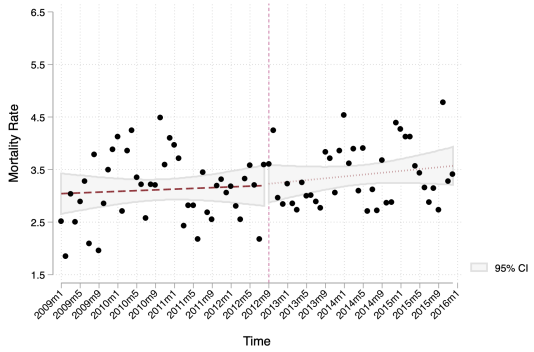
(A) NATIONALITIES WITH % OF UNDOCUMENTED > 0 (UPPER TERCILE)



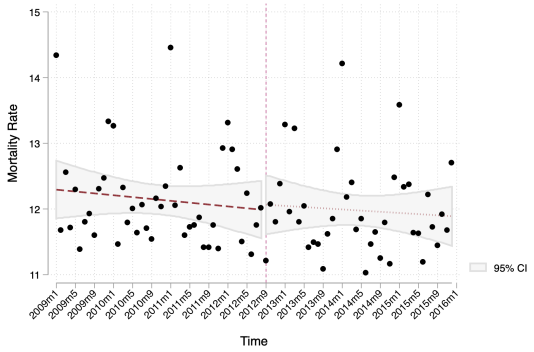
(B) NATIONALITIES WITH % OF UNDOCUMENTED > 0 (MIDDLE TERCILE)



(C) NATIONALITIES WITH % OF UNDOCUMENTED > 0 (LOWER TERCILE)

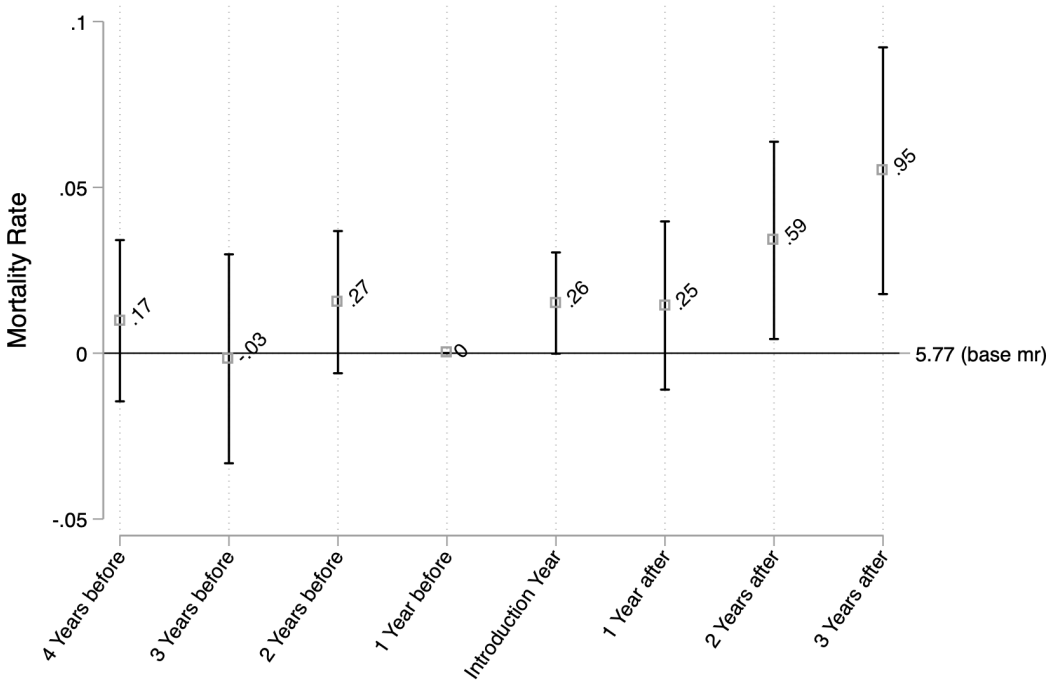


(D) NATIONALITIES WITH % OF UNDOCUMENTED = 0



Notes: The figures show scatterplots of the monthly mortality rates expressed as deaths per 100000 individuals. They include linear fits with 95% confidence intervals. The vertical line indicates the implementation of the restriction in access to the healthcare. The terciles thresholds are built using the population of each nationality and its estimated undocumented percentage (population weighted).
Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

FIGURE 3—EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON THE MORTALITY OF UNDOCUMENTED IMMIGRANTS. EVENT STUDY ESTIMATES

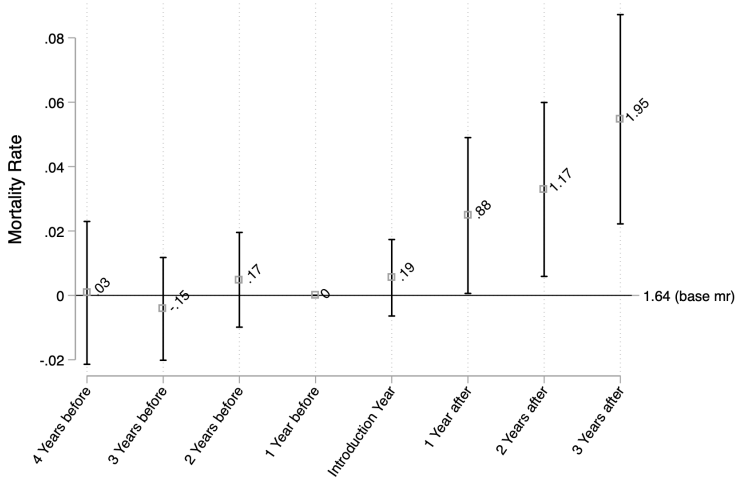


Notes: The figure shows the interaction coefficients of the event study (equation 2) with 95% confidence intervals. For each year, the coefficient measures that year's increase in the difference in mortality rates between undocumented immigrants and the control group with respect to 1 year before the implementation of the reform. The figure also reports, for each year, the percentage change in the mortality rate with respect to the base year and the mean mortality rate of the base year for an increase of one percentage point of undocumented migration.

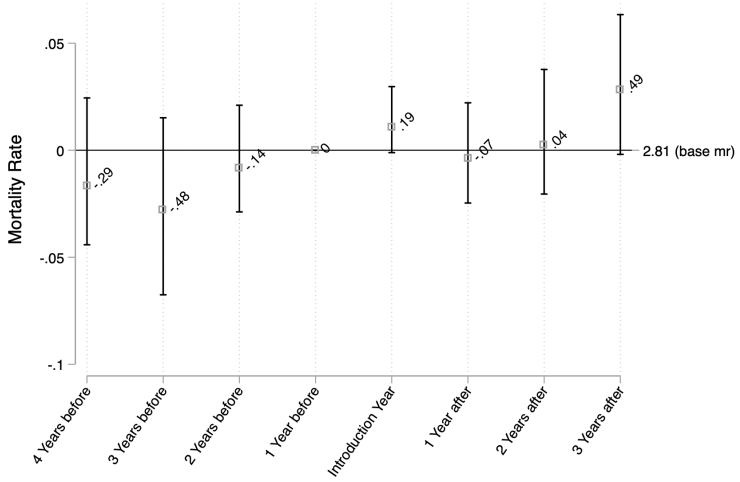
Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

FIGURE 4—EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON THE MORTALITY OF UNDOCUMENTED IMMIGRANTS. EVENT STUDY ESTIMATE FOR AMENABLE MORTALITY AND NON-AMENABLE MORTALITY

(A) AMENABLE MORTALITY



(B) NON-AMENABLE MORTALITY



Notes: The figure shows the interaction coefficients of the event study (equation 2) for amenable and non-amenable mortality with 95% confidence intervals. For each year, the coefficient measures that year's increase in the difference in mortality rates between undocumented immigrants and the control group with respect to 1 year before the implementation of the reform. The figure also reports, for each year, the percentage change in the mortality rate with respect to the base year and the mean mortality rate of the base year for an increase of one percentage point of undocumented migration.
Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

TABLE 1—*EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON THE MORTALITY OF UNDOCUMENTED IMMIGRANTS. DIFFERENCES-IN-DIFFERENCES ESTIMATES*

	(1)	(2)	(3)	(4)
Percentage × Post	0.0180**		0.0176**	
	(0.00800)		[0.04]	
Percentage × Year1		0.00988		0.0235**
		(0.00835)		[0.04]
Percentage × Year2		0.00897		0.0092
		(0.0104)		[0.44]
Percentage × Year3		0.0288**		0.0150
		(0.0131)		[0.48]
Percentage × Year4		0.0499***		0.0410
		(0.0180)		[0.12]
$PercentageUndoc.$	-0.535***	-0.538***	-0.108**	-0.112
	(0.00563)	(0.00568)	[0.04]	[0.04]
$PostReform$	-0.287***		-0.419	
	(0.0650)		[0.2]	
Only undocumented-positive countries	No	No	Yes	Yes
Observations	3612	3612	1848	1848
R^2	0.8512	0.8503	0.2555	0.2545
Pre-Reform mortality rate	6.31	6.31	6.31	6.31

* p <0.1, ** p <0.05, *** p <0.01.

Notes: The dependent variable is the monthly mortality rate expressed as deaths per 100000 individuals. Only undocumented-positive countries (regressions 3 and 4) exclude the countries with zero undocumented immigrants. Standard errors (in parentheses) are clustered at the country of nationality level, for only undocumented-positive countries the standard errors are calculated the wild bootstrapping method proposed in Cameron *et al.* (2008) and p-values are reported [in brackets]. Dynamic evolution are estimated for the first year, the second year, the third year and the fourth year (only one quarter included) following the introduction of the reform (regressions 2 and 4). Regressions include fixed effects at the country of nationality, year and month level. Regressions include population weights.

Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

TABLE 2—*EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON THE MORTALITY OF UNDOCUMENTED IMMIGRANTS. DIFFERENCES-IN-DIFFERENCES ESTIMATES BY GENDER*

	(1) Men	(2) Women	(3) Men	(4) Women	(5) Men	(6) Women
Percentage × Post	0.0397***	-0.00160	0.0196*	0.0140	0.0162*	0.00919***
	(0.0126)	(0.00768)	[0.08]	[0.12]	[0.08]	[<0.01]
$PercentageUndoc.$	-0..474***	-0.360***	-0.168**	-0.112**	-0.199**	-0.0191**
	(0.00848)	(0.00582)	[0.04]	[0.04]	[0.04]	[0.04]
$PostReform$	-0.523***	-0.0489	-0.108	-0.740	-0.299	-0.737**
	(0.130)	(0.0508)	[0.88]	[0.12]	[0.48]	[0.04]
Only undocumented-positive countries	No	No	Yes	Yes	Yes	Yes
Only amenable mortality	No	No	No	No	Yes	Yes
Observations	3612	3612	1848	1848	1848	1848
R^2	0.8232	0.6454	0.1937	0.1042	0.2157	0.1255
Pre-Reform mortality rate	7.61	4.87	7.61	4.87	3.50	2.61

* p <0.1, ** p <0.05, *** p <0.01.

Notes: The dependent variable is the monthly mortality rate expressed as deaths per 100000 individuals. Only undocumented-positive countries (regressions 3, 4, 5 and 6) exclude the countries with zero undocumented immigrants. Columns 5 and 6 just includes the deaths due to amenable causes. Standard errors (in parentheses) are clustered at the country of nationality level, for only undocumented-positive countries the standard errors are calculated the wild bootstrapping method proposed in Cameron *et al.* (2008) and p-values are reported [in brackets]. Regressions include fixed effects at the country of nationality, year and month level. Regressions include population weights.

Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

TABLE 3—*EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON THE MORTALITY OF UNDOCUMENTED IMMIGRANTS. DIFFERENCES-IN-DIFFERENCES ESTIMATES BY AGE GROUPS*

	(1) Ages 2-17	(2) Ages 18-39	(3) Ages 40-64	(4) Ages 2-17	(5) Ages 18-39	(6) Ages 40-64
Percentage × Post	0.00801**	0.0210***	0.0512**	0.00500	0.0240***	0.0389
	(0.0038)	(0.0061)	(0.0198)	[0.16]	[<0.01]	[0.28]
$PercentageUndoc.$	0.0969***	-0.115***	-0.889***	-0.0225**	-0.0575**	-0.2631**
	(0.00219)	(0.00282)	(0.0100)	[0.04]	[0.04]	[0.04]
$PostReform$	-0.03951	-0.00972	-0.586***	-0.0367	0.0856	-2.2638**
	(0.0283)	(0.0532)	(0.138)	[1]	[0.68]	[0.04]
Only undoc-positive countries	No	No	No	Yes	Yes	Yes
Observations	3504	3612	3612	1740	1860	1860
R^2	0.0739	0.2390	0.7519	0.0486	0.1254	0.2426
Pre-Reform mortality rate	1.37	2.82	10.68	1.37	2.82	10.68

* p <0.1, ** p <0.05, *** p <0.01.

Notes: The dependent variable is the monthly mortality rate expressed as deaths per 100000 individuals. Only undocumented-positive countries (regressions 4, 5 and 6) exclude the countries with zero undocumented immigrants. Standard errors (in parentheses) are clustered at the country of nationality level, for only undocumented-positive countries the standard errors are calculated the wild bootstrapping method proposed in Cameron *et al.* (2008) and p-values are reported [in brackets]. Regressions include fixed effects at the country of nationality, year and month level. Regressions include population weights.

Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

TABLE 4—*EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON THE MORTALITY OF UNDOCUMENTED IMMIGRANTS. DIFFERENCES-IN-DIFFERENCES ESTIMATES FOR AMENABLE AND NON-AMENABLE MORTALITY: AGE-GROUP 2-17*

	Amenable		Non-Amenable	
	(1)	(2)	(3)	(4)
Percentage × Post	0.00403	0.00209	0.00189	-0.00109
	(0.00262)	[0.44]	(0.00242)	[0.84]
$PercentageUndoc.$	0.0794***	-0.0153**	0.0589***	-0.00690**
	(0.00144)	[0.04]	(0.00137)	[0.04]
$PostReform$	-0.0652***	-0.100	-0.0659**	0.182
	(0.0173)	[0.56]	(0.0279)	[0.48]
Only undocumented-positive countries	No	Yes	No	Yes
Observations	2988	1644	3132	1620
R^2	0.0398	0.0452	0.0473	0.0389
Pre-Reform mortality rate	0.55	0.55	0.76	0.76

* p <0.1, ** p <0.05, *** p <0.01.

Notes: The dependent variable is the monthly mortality rate expressed as deaths per 100000 individuals. Only undocumented-positive countries (regressions 2 and 4) exclude the countries with zero undocumented immigrants. Standard errors (in parentheses) are clustered at the country of nationality level, for only undocumented-positive countries the standard errors are calculated the wild bootstrapping method proposed in Cameron *et al.* (2008) and p-values are reported [in brackets]. Regressions include fixed effects at the country of nationality, year and month level. Regressions include population weights.

Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

TABLE 5—*EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON THE MORTALITY OF UNDOCUMENTED IMMIGRANTS. DIFFERENCES-IN-DIFFERENCES ESTIMATES FOR AMENABLE AND NON-AMENABLE MORTALITY*

	Amenable				Non-Amenable			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Percentage × Post	0.0226***		0.0126***		0.00348		0.00317	
	(0.00656)		[<0.01]		(0.00390)		[0.64]	
Percentage × Year1		0.00521		0.0103		-0.00122		-0.00123
		(0.00583)		[0.32]		(0.00494)		[1]
Percentage × Year2		0.0245**		0.0114*		0.00298		0.00103
		(0.00989)		[0.08]		(0.00455)		[0.96]
Percentage × Year3		0.0326***		0.0101		0.00944		0.00956
		(0.0105)		[0.12]		(0.00718)		[0.48]
Percentage × Year4		0.0544***		0.0374***		0.00328		0.00796
		(0.0141)		[<0.01]		(0.00794)		[0.44]
$PercentageUndoc.$	-0.303***	-0.303***	-0.118**	-0.128**	-0.218***	-0.217***	-0.0395**	-0.0408**
	(0.00469)	(0.00436)	[0.04]	[0.04]	(0.00291)	(0.00291)	[0.04]	[0.04]
$PostReform$	-0.173***		-0.501*		-0.110***		-0.101	
	(0.0515)		[0.08]		(0.0238)		[0.8]	
Only undoc-positive	No	No	Yes	Yes	No	No	Yes	Yes
Observations	3612	3612	1848	1848	3612	3612	1848	1848
R^2	0.8575	0.8573	0.2686	0.2678	0.7174	0.7159	0.1094	0.1079
Pre-Reform mr	3.24	3.24	3.24	3.24	1.87	1.87	1.87	1.87

* p <0.1, ** p <0.05, *** p <0.01.

Notes: The dependent variable is the monthly mortality rate expressed as deaths per 100000 individuals. Only undocumented-positive countries (regressions 3, 4, 7 and 8) exclude the countries with zero undocumented immigrants. Standard errors (in parentheses) are clustered at the country of nationality level, for only undocumented-positive countries the standard errors are calculated the wild bootstrapping method proposed in Cameron *et al.* (2008) and p-values are reported [in brackets]. Regressions include fixed effects at the country of nationality, year and month level. Regressions include population weights.

Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

TABLE 6—*EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON THE MORTALITY OF UNDOCUMENTED IMMIGRANTS. DIFFERENCES-IN-DIFFERENCES ESTIMATES BY CAUSE OF DEATH*

	(1) Infections	(2) Tumors	(3) Blood	(4) Endocrine	(5) Mental	(6) Nervous	(7) Circulatory	(8) Respiratory	(9) Digestive	(10) Osteomuscular	(11) Genitourinary	(12) Malformations	(13) Other Symptoms	(14) External
Perc. $\times$ **Post**	0.286*	1.0788***	-0.0820	0.175**	0.0527	-0.0106	0.449*	0.239**	0.205**	0.0546	0.0522	0.123*	0.0850	-0.0101
	(0.142)	(0.344)	(0.0686)	(0.0802)	(0.0328)	(0.0791)	(0.246)	(0.0930)	(0.0881)	(0.0336)	(0.0387)	(0.0615)	(0.139)	(0.271)
$Perc.Undoc.$	-1.343***	-17.908***	-0.216***	-1.119***	-0.702***	0.0587*	-15.498***	-6.264***	-3.648***	-0.412***	-0.412***	0.603***	-3.945***	-13.039***
	(0.0712)	(0.1626)	(0.0345)	(0.0400)	(0.0159)	(0.0399)	(0.117)	(0.0450)	(0.0420)	(0.0169)	(0.0192)	(0.0310)	(0.0698)	(0.137)
$PostReform$	-0.0314*	-0.0686**	0.017	-0.0109	0.0010	-0.0117**	0.0078	-0.0380***	0.0216	-0.0145***	-0.0096***	-0.0086	-0.0827***	0.0142
	(0.0174)	(0.0277)	(0.0074)	(0.0111)	(0.0030)	(0.0055)	(0.0137)	(0.0078)	(0.0184)	(0.0042)	(0.0030)	(0.0074)	(0.0086)	(0.0231)
Only undoc. countries	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Observation	3,576	3,612	3,156	3,120	2,604	3,516	3,612	3,516	3,504	2,688	3,072	2,952	3,556	3,612
R^2	0.1720	0.8599	0.0345	0.2115	0.0958	0.2830	0.6100	0.3883	0.4196	0.0258	0.0846	0.2326	0.1988	0.3312
Pre-Reform mr	0.27	1.45	0.070	0.056	0.020	0.11	0.87	0.25	0.20	0.034	0.027	0.10	0.41	1.01

* p <0.1, ** p <0.05, *** p <0.01.

Notes: The dependent variable is the monthly mortality rate expressed as deaths per 100000 individuals. Standard errors (in parentheses) are clustered at the country of nationality level. Regressions include fixed effects at the country of nationality, year and month level. Regressions include population weights.

Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

TABLE 7—*EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON POPULATION. DIFFERENCES-IN-DIFFERENCES ESTIMATES*

	Ln(population)			Population		
	Both	Men	Women	Both	Men	Women
	(1)	(2)	(3)	(4)	(5)	(6)
Percentage × Post	0.0000276	-0.000183	0.00142	246.3337	214.175	32.158
	(0.00155)	(0.00158)	(0.00214)	(277.087)	(158.780)	(126.719)
$PercentageUndoc.$	0.0706***	0.0905***	0.0290***	1615.789***	1430.297***	185.492***
	(0.000720)	(0.000738)	(0.000954)	(128.647)	(73.719)	(58.834)
$PostReform$	-0.0105	0.000445	-0.0183	-4198.814	-3408.313	-790.503
	(0.0207)	(0.0212)	(0.0295)	(4148.408)	(2388.662)	(1864.01)
Observations	3612	3612	3612	3612	3612	3612

* p <0.1, ** p <0.05, *** p <0.01.

Notes: The dependent variable is the logarithm of the population in columns 1 through 3 and the population (number of individuals) in columns 4 through 6. Standard errors (in parentheses) are clustered at the country of nationality level. Regressions include fixed effects at the country of nationality, year and month level.

Source: Data from the Spanish National Institute of Statistics 2009 to 2015.

TABLE 8—*EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON EDUCATIONAL AND AGE COMPOSITION OF POPULATION. DIFFERENCES-IN-DIFFERENCES ESTIMATES*

	(1) Primary Edu & Illiterate	(2) Secundary Edu	(3) Tertiary Edu	(4) Less than 10 y.o.	(5 Less than 50 y.o.
Treated × Post	0.0112***	-0.0136***	-0.0135	0.0064	-0.005
	(0.0007)	(0.0003)	(0.0066)	(0.0098)	(0.0088)
$Treated$	0.0749***	0.0108***	-0.120***	0.0466***	0.3063***
	(0.0010)	(0.0012)	(0.0046)	(0.0067)	(0.0060)
$PostReform$	-0.0629***	0.0139***	0.0351***	-0.0028**	-0.0406***
	(0.0004)	(0.0005)	(0.0003)	(0.0006)	(0.0003)
Observations	991,299	991,299	991,299	991,299	991,299
Pre-reform Rate	0.25	0.28	0.13	0.11	0.91

* p <0.1, ** p <0.05, *** p <0.01.

Notes: Standard errors (in parentheses) are clustered at the region of nationality level. Regressions include fixed effects at the level of the Spanish region, region of nationality and year.

Source: Data from the Spanish Labour Force Survey 2009 to 2015 (second quarter interviews).

TABLE 9—*EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON THE MORTALITY OF UNDOCUMENTED IMMIGRANTS. DIFFERENCES-IN-DIFFERENCES ESTIMATES EXPLOITING BOTH COUNTRY OF NATIONALITY AND COUNTRY OF BIRTH*

	(1)	(2)	(3)	(4)
Immigrant × Post	0.0172**	0.0181**	0.0145*	0.0140*
	(0.00735)	(0.00728)	(0.0072)	(0.0073)
$ImmigrantPercentage$	-0.107***	-0.108***	-0.117	-0.128
	(0.0361)	(0.0365)	(0.0947)	(0.0924)
$PostReform$	-0.502***	-0.387	-0.351***	-0.371
	(0.161)	(0..285)	(0.126)	(0.337)
Only undocumented-positive countries	No	No	Yes	Yes
FE country of birth	X	X	X	X
FE year, month		X		X
Observations	63264	63264	23304	23304
Pre-Reform mortality rate	8.36	8.36	8.36	8.36

* p <0.1, ** p <0.05, *** p <0.01.

Notes: The dependent variable is the monthly mortality rate expressed as deaths per 100000 individuals. Only undocumented-positive countries (regressions 3 and 4) exclude the countries with zero undocumented immigrants. Standard errors (in parentheses) are clustered at the country of birth level. Regressions include population weights.

Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

TABLE 10—*EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON THE MORTALITY OF UNDOCUMENTED IMMIGRANTS. DIFFERENCES-IN-DIFFERENCES ESTIMATES AT THE REGIONAL LEVEL*

	(1)	(2)	(3)	(4)
Percentage × Post	0..0179***	0.0206***	0.0127**	0.0121**
	(0.0030)	(0.0034)	(0.0047)	(0.0042)
$PercentageUndoc.$	-0..364***	-0.366***	-0.097*	-0.0964*
	(0.0783)	(0.0783)	(0.0496)	(0.0497)
$PostReform$	-0.240*	-0.244*	-0.185	-0.173
	(0.127)	(0.127)	(0.307)	(0.307)
Only undocumented-positive countries	No	No	Yes	Yes
FE region	X	X	X	X
FE year, month	X	X	X	X
Region specific linear trends		X		X
Observations	51702	51702	26544	26544
R^2	0.4065	0.4075	0.0211	0.0216
Pre-Reform mortality rate	6.77	6.77	6.77	6.77

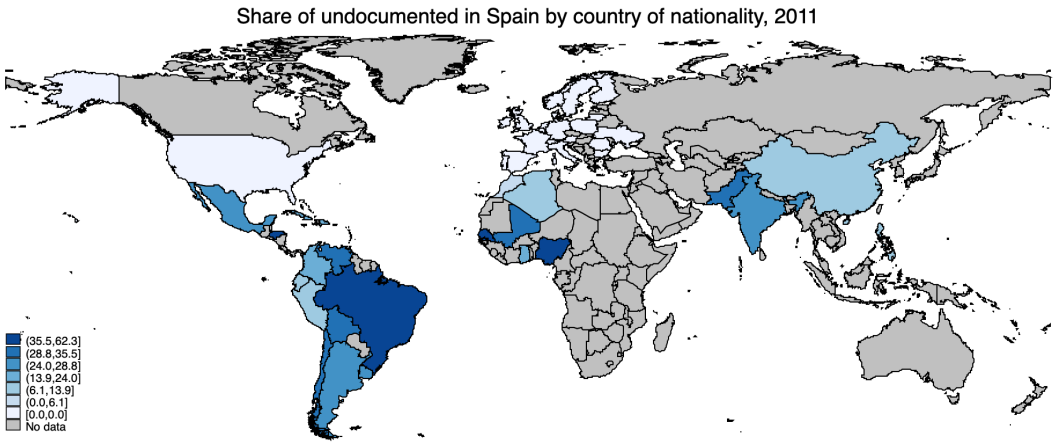
* p <0.1, ** p <0.05, *** p <0.01.

Notes: The dependent variable is the monthly mortality rate expressed as deaths per 100000 individuals. Only undocumented-positive countries (regressions 3 and 4) exclude the countries with zero undocumented immigrants. Standard errors (in parentheses) are clustered at the Spanish region level. Regressions include population weights.

Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

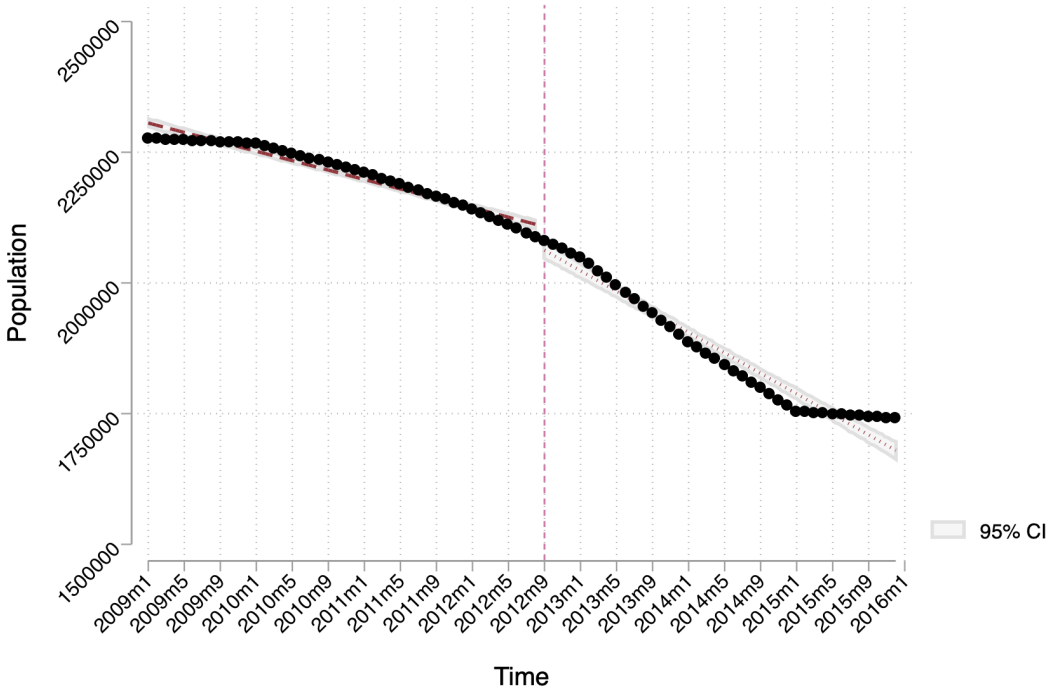
Appendix

FIGURE A1—SHARE OF UNDOCUMENTED IN SPAIN BY COUNTRY OF NATIONALITY, 2011



Notes: For each nationality, we calculate the percentage of individuals living in Spain in 2011 in an irregular situation in the following manner: from the 2011 Census we take the number of individuals from a given nationality living in Spain and we subtract from that the number of individuals from that same nationality that have residence or student permits in Spain in 2011. Thus, we get the number of individuals without a residence/student permit in 2011 for a given nationality and we divide it by the total number of individuals from that nationality from the 2011 Census in order to get a percentage of undocumented individuals.
Source: Data from the Spanish Census in 2011 (population data by nationality) and The Spanish Ministry of Employment and Social Security (residence and student permits data by nationality in 2011).

FIGURE A2—EVOLUTION OF THE POPULATION OF IMMIGRANTS DURING ANALYSIS PERIOD 2009-2015



Notes: The figure shows the evolution of the population of immigrants in Spain (of the analyzed countries with a positive proportion of undocumented immigrants). The vertical line indicates the implementation of the restriction in access the healthcare.
Source: Data from the Spanish National Institute of Statistics 2009 to 2015.

TABLE A1—*COUNTRY OF NATIONALITY WITH ZERO PROPORTION OF UNDOCUMENTED IN 2011*

Country of Nationality	Prop. of Undoc. Immigrants 2011	Country of Nationality	Prop. of Undoc. Immigrants 2011
Austria	0	Morocco	0.052
Belgium	0	China	0.061
Bulgaria	0	Peru	0.097
Denmark	0	Phillipines	0.103
Finland	0	Ecuador	0.106
France	0	Algeria	0.131
Germany	0	Colombia	0.146
Ireland	0	Dominican Republic	0.168
Italy	0	Cuba	0.191
Lithuania	0	Gambia	0.230
Netherlands	0	Ghana	0.240
Norway	0	Mexico	0.256
Poland	0	India	0.261
Portugal	0	Uruguay	0.272
Romania	0	Argentina	0.280
Spain	0	Pakistan	0.295
Sweden	0	Chile	0.299
Switzerland	0	Mali	0.321
Ukraine	0	Venezuela	0.337
United States of America	0	Bolivia	0.355
United Kingdom	0	Senegal	0.366
		Nigeria	0.371
		Brazil	0.431
		Honduras	0.610

Notes: For each nationality, we calculate the percentage of individuals living in Spain in 2011 in an irregular situation in the following manner: from the 2011 Census we take the number of individuals from a given nationality living in Spain and we subtract from that the number of individuals from that same nationality that have a residence or student permit in 2011. Thus, we get the number of individuals without a residence or student permit in 2011 for a given nationality and we divide it by the total number of individuals from that nationality from the 2011 Census in order to get a percentage of undocumented individuals.

Source: Data from the Spanish Census in 2011 (population data by nationality) and The Spanish Ministry of Employment and Social Security (residence permits data by nationality in 2011).

TABLE A2—*APPENDIX TABLE: EFFECT OF RESTRICTION IN HEALTHCARE ACCESS ON THE MORTALITY OF UNDOCUMENTED IMMIGRANTS. DIFFERENCES-IN-DIFFERENCES ESTIMATES USING AGE-ADJUSTED LOGARITHM MORTALITY RATES*

	All mortality		Amenable		Non-Amenable	
	(1)	(2)	(3)	(4)	(5)	(6)
Percentage × Post	0.00327		0.00428**		0.00291	
	[0.12]		[0.04]		[0.44]	
Percentage × Year1		0.00443		0.00271		.00218
		[0.16]		[0.68]		[0.44]
Percentage × Year2		.000551		0.00361		0.000563
		[1]		[0.24]		[1]
Percentage × Year3		0.00384		0.00476		0.00609
		[0.4]		[0.36]		[0.32]
Percentage × Year4		0.00790		0.0121**		0.00380
		[0.12]		[0.04]		[0.36]
$PercentageUndoc.$	-0.0140**	-0.0150**	-0.0344**	-0.0348**	-0.0124 **	-0.0133**
	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]
$PostReform$	-0.0674		-0.220*		-0.0424	
	[0.32]		[0.08]		[0.84]	
Only undocumented-positive countries	Yes	Yes	Yes	Yes	Yes	Yes
Age-adjusted mortality	Yes	Yes	Yes	Yes	Yes	Yes
Logarithm mortality	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1848	1848	1848	1848	1848	1848
R^2	0.1491	0.1484	0.2245	0.2244	0.1317	0.1292
Pre-Reform log adj mortality rate	2.21	2.21	1.45	1.45	1.00	1.00

* p <0.1, ** p <0.05, *** p <0.01.

Notes: The dependent variable is the monthly mortality rate expressed as deaths per 100000 individuals. Only undocumented-positive countries (regressions 3, 4, 7 and 8) exclude the countries with zero undocumented immigrants. Standard errors (in parentheses) are clustered at the country of nationality level, for only undocumented-positive countries the standard errors are calculated the wild bootstrapping method proposed in Cameron *et al.* (2008) and p-values are reported [in brackets]. Regressions include fixed effects at the country of nationality, year and month level. Regressions include population weights.

Source: Data from the Spanish Mortality Registers 2009 to 2015 and population data from the Spanish National Institute of Statistics.

Supplementary Files

TABLE S1—REGIONS INCLUDED IN THE CONTROL AND TREATMENT GROUP IN THE SPANISH LABOUR FORCE SURVEY DATASET.

Control Group		Treatment Group	
Country	Region	Country	Region
Spain	EU-15	Argelia	Africa
Germany	EU-15	Cape Verde	Africa
Austria	EU-15	Egipt	Africa
Belgium	EU-15	Gambia	Africa
Denmark	EU-15	Equatorial Guinea	Africa
Finland	EU-15	Libya	Africa
France	EU-15	Morocco	Africa
Greece	EU-15	Senegal	Africa
Irland	EU-15	South Africa	Africa
Italy	EU-15	Sudan	Africa
Luxemburg	EU-15	Occidental Sahara	Africa
The Netherlands	EU-15	Tunisia	Africa
Portugal	EU-15	Ethiopia	Africa
United Kingdom	EU-15	Angola	Africa
Sweden	EU-15	Democratic Republic of Congo	Africa
Cyprus	EU-25	Camerun	Africa
Slovenia	EU-25	Ghana	Africa
Estonia	EU-25	Guinea	Africa
Hungary	EU-25	Guinea-Bissau	Africa
Latvia	EU-25	Mali	Africa
Lithuania	EU-25	Mauritania	Africa
Malta	EU-25	Nigeria	Africa
Poland	EU-25	Other African Countries	Africa
Czech Republic	EU-25	Costa Rica	Centre-America and Caribbean
Slovakia	EU-25	Cuba	Centre-America and Caribbean
Bulgaria	EU-27	El Salvador	Centre-America and Caribbean
Romania	EU-27	Guatemala	Centre-America and Caribbean
Canada	North-America	Haití	Centre-America and Caribbean
USA	North-America	Honduras	Centre-America and Caribbean
		México	Centre-America and Caribbean
		Nicaragua	Centre-America and Caribbean
		Panamá	Centre-America and Caribbean
		Puerto Rico	Centre-America and Caribbean
		República Dominicana	Centre-America and Caribbean
		Other Countries in Central America and the Caribbean	Centre-America and Caribbean
		Argentina	South-America
		Bolivia	South-America
		Brasil	South-America
		Chile	South-America
		Colombia	South-America
		Ecuador	South-America
		Paraguay	South-America
		Perú	South-America
		Uruguay	South-America
		Venezuela	South-America

Notes: These are the regions and countries that can be included and how we classify them into the treatment and control group using the percentage of undocumented for each nationality living in Spain in 2011. We try to match as much as possible the same countries than in the mortality registers although the LFS includes a larger number of countries than the mortality registers.
Source: Spanish Labour Force Survey 2009 to 2015 (second quarter interviews).

TABLE S1 CONTINUED—REGIONS INCLUDED IN THE CONTROL AND TREATMENT GROUP IN THE SPANISH LABOUR FORCE SURVEY DATASET.

Control Group		Treatment Group	
Country	Region	Country	Region
		Other Countries in South America	South-America
		China	Eastern Asia
		North Korea	Eastern Asia
		South Korea	Eastern Asia
		Japan	Eastern Asia
		Mongolia	Eastern Asia
		Taiwan	Eastern Asia
		Saudi Arabia	Middle-East
		Irak	Middle-East
		Israel	Middle-East
		Jordan	Middle-East
		Lebanon	Middle-East
		Syria	Middle-East
		Palestine	Middle-East
		Other Countries in the Middle East	Middle-East
		Bangladesh	South Asia
		Cambodia	South Asia
		Philippines	South Asia
		India	South Asia
		Indonesia	South Asia
		Iran	South Asia
		Laos	South Asia
		Pakistan	South Asia
		Sri Lanka	South Asia
		Thailand	South Asia
		Vietnam	South Asia
		Kazajstan	South Asia
		Kirguistan	South Asia
		Tayikistan	South Asia
		Turkmenistan	South Asia
		Uzbekistan	South Asia
		Other Countries in South Asia	South Asia

Notes: These are the regions and countries that can be included and how we classify them into the treatment and control group using the percentage of undocumented for each nationality living in Spain in 2011. We try to match as much as possible the same countries than in the mortality registers although the LFS includes a larger number of countries than the mortality registers.
Source: Spanish Labour Force Survey 2009 to 2015 (second quarter interviews).